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# CONFIDENTIAL

NEW REAGENT SYSTEMS -

PLANT TRIAL AT

WINDSOR MINERALS INC.

G. LEE
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WAA
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Plaintiff's Exhibit J&J 335

INTRODUCTION:

Windsor Minerals has been actively engaged in a froth floatation research program for the past year and a half. This program has developed two floatation reagent systems which offer substantial advantages to the Windsor floatation process from an economic, purity and potential health hazard point of view.

In the absence of known deleterious effects attributable to these reagent systems and in response to the favorable results in testing performed by Baby Products Research in New Brunswick, Windsor Minerals scheduled a plant trial as a guide for establishment of the product and process parameters under actual operating conditions.

The plant trial was conducted on January 29, 1974. During this trial cosmetic grade talcs were produced using both new reagent systems, i.e., n-butyl alcohol and n-bytyl alcohol-citric acid in combination.

The following report will deal with the product and process parameters of the trial as determined by Windsor Minerals and outside consultants.

CONCLUSIONS

1. A reduction in total acid soluble materials was attributable to the new reagent systems. The magnitude of the reduction was 23% for n-butanol and 28% for n-butanol-citric acid.

2. A similar decrease in "magnesite' levels was effected. The decrease was 23% using n-butanol and 30% for the n-butanol-citric acid combination.

3. A color (reflectance) increase of 1.0 units was effected while using n-butanol; an increase of 1.4 units was attributed to the n-butanol-citric acid system.

4. Chrysotile fiber supression was indicated while using the n-butanol-citric acid system.

5. Talc recoveries were higher while using the new reagent systems. The increases were 17% for n-butanol and 19% for n-butanol-citric acid.

6. The chlorite content of the floated product was reduced 14% while using n-butanol and 15% while using n-butanol-citric acid.

7. A substantial decrease in the bulk density of the product was noted while using the new reagent systems. The decreases were 2.06 $lb/ft^3$ and 2.82 $lb/ft^3$ respectively for the n-butanol and n-butanol-citric acid systems, corresponding to decreases on a percentage basis of 8.4% and 13.0%.

8. The platy nature of the talc product was found to be unchanged by the use of the new reagent systems.

9. The pH of n-butanol-citric acid floated talc was significantly closer to neutrality than current production. The decrease in alkalinity was measured to be 1.25 pH units for material made during the plant trial.

10. Particle size distribution profiles were similar for materials floated with Ultrawet D.S., n-butanol, and n-butanol-citric acid.

11. Optical microscopy indicates a high degree of similarity with relation to the size and shape factors of materials produced during the plant trial.

Minor differences were noted with respect to talc shards and rolled edges. The product differences, however, correspond quite closely with differences found in the ores from which the products were beneficiated.

OPERATIONAL DESCRIPTION

At 4:30 AM on January 29, 1974, immediately prior to the plant trial using the n-butanol based reagent systems, 1000 pounds of Ultrawet D.S. floated talc was collected and packaged in 4 fiber drums. At the same time a representative ore sample was collected. These materials were used as a reference for the plant trial products.

The floatation circuit was then purged for 3 hours to remove the residual Ultrawet, after which n-butyl alcohol was added at a rate of 1.08 liters per ton of floatation feed.

Sampling was begun after 30 minutes and continued on a 30 minute basis thereafter. The samples were immediately analyzed by the Windsor Minerals Q.A. Laboratory.

After establishing that equilibrium conditions had been reached in the floatation circuitry a 1000 pound sample of finished product was taken and stored in fiber drums for further studies.

Following collection of the n-butanol floated product, citric acid was added to the circuit at a rate of 4 pounds of citric acid per ton of floatation feed, while maintaining the n-butanol additions as before. When the circuit was judged to have reached equilibrium conditions based upon the analytical results, another 1000 pound sample of finished product was taken and stored in fiber drums, also for future studies.

0.2%

SAMPLING

Production sampling for quality assurance purposes was begun at 9:30 AM on 1/29/74 and continued at half hour intervals for the duration of the plant trial. The following table lists the materials sampled and the analyses performed during the trial.

Table 1 Quality Assurance Analytical Schedule

| Material Sampled | Sample Qty. | % Acid Insolubles | Color Reflectance | pH | -325 Mesh Screen | Bulk Density | % Magnesite |
|---|---|---|---|---|---|---|---|
| Ore | 500g | X | X | | X | | |
| Tailings | 250cc | X | | | | | |
| Cleaner Concentrate | 500cc | X | X | X | | | |
| Product | 500g | X | X | X | X | X | X |

Composite ore and tailings samples were collected 30 minutes prior to and during each product collection. A product composite for each reagent system used was also obtained from the material packaged in fiber drums.

The composites were then used for the development of analytical data for comparative purposes in assessing the effects of the reagent systems upon the process and resulting products.

EXPERIMENTAL & RESULTS

Table 2 displays a compilation of Quality Assurance data obtained during the test run. The results were used for circuit control, establishment of operational parameters, and talc recovery calculations.

Product composite samples representing materials made with Ultrawet D.S., n-butanol and n-butanol-citric acid were analyzed in accordance with our standard certification procedures. These results, in the form of a standard laboratory report are given in Tables 3, 4 and 5. The data in these tables confirms that the new reagent systems provide substantially improved products in the following categories:

1. total acid solubles
2. magnesite
3. color
4. bulk density
5. pH

There were no specification categories in which a decrease in product qualities were observed.

Table 6 provides the trial results in terms of talc recovery.

Talc recovery was calculated using the relationship:

$$\% \text{ Recovery} = 100 \frac{(H-T)}{(C-T)} \times \frac{C}{H}$$

where:

H = % acid insoluble content of ore

T = % acid insoluble content of tailings

C = % acid insoluble content of cleaner concentrate

Recoveries were derived by obtaining mean acid insoluble values for ore, tailings, and cleaner concentrates from Table 2 for the time period during which the specified reagent was used. These values were compared to the 8 hour production shift immediately preceding the reagent trial during which time Ultrawet D.S. was the floatation reagent. It is apparent from Table 6 that a substantially higher recovery is afforded by the use of n-butanol based floatation systems.

Particle size measurements were performed by two methods; sedimentation velocity using the Andreasen Sedimentation Pipette and by actual optical measurement using the TIMC Image Analyzing system. The results are given in Tables 7-12 and graphically displayed in Figures 1-9.

The particle size distribution profiles indicate the similarity of the products within the framework of the technique used for measurement. However, we have noted and confirmed that differences between the techniques and the values obtained via the techniques do exist. It has been our experience that the direct measurement of particle size and shape which is possible with the Image Analyzing method is a superior determination to the indirect measurements made by the sedimentation method.

On this basis,potential benefit is indicated in that the optical measuring technique has verified a lower fine particle content reporting in the finished product when using the alcohol based systems, particularly the n-butanol-citric acid system. This fact has been confirmed by Walter C. McCrone Associates who have reported the same conclusions based on their optical studies.

Mineralogical examinations for detection of amphiboles were performed by Dr. R. Reynolds at Dartmouth College on the composite ore and product samples. The results for the Ultrawet D.S., n-butanol and n-butanol-citric acid floated products are given in Table 13 and Attachment C, titled "Mineralogy of Ores, Product and Mill Tails Re Different Floatation Reagents".

There were no significant differences with respect to the amphibole content in the test products. The detected amphibole minerals did not appear in a fibrous form in any of the product samples.

Mineralogical analyses using X-ray diffraction techniques were performed on the composite ore, tailings and talc products during each segment of the reagent trial periods. This work was performed by Dr. Reynolds; the results are given in Table 14 and Figure 10.

The gross mineralogical content of the three ore samples were essentially the same.

Analysis of the finished products by X-ray techniques indicate a substantial reduction in chlorite content attributable to the alcohol based systems.

Analysis of the tailings resulting from the use of the three different reagent systems by X-ray diffraction identifies a profound difference in the mineralogical composition. As shown in Figure 10, talc peaks in the alcohol based system tails are roughly one tenth the intensity as found in the Ultrawet system tails. Optical microscopic examination of the tailing fractions from the alcohol based systems also indicates that the small quantity of talc present is essentially all a blocky or non-platy variety. These results confirm the substantial talc recovery differences between the Ultrawet and n-butanol based systems which had been independently determined by chemical analyses.

Asbestiform analyses were performed by Walter C. McCrone Associates by means of transmission electron microscopy and electron diffraction techniques. Their report is found in attachment "A". An abstract of their findings is given in Table 15. Quantitative treatment of these results is questionable due to the extremely low chrysotile levels present, however depression of chrysotile through the use of citric acid in combination with n-butanol is indicated. To better quantify the depressive affects of citric acid upon magnesium surfaced asbestiforms, Attachment "B" titled "Asbestiform depression through the use of new floatation reagent systems" is included to provide details of an earlier study in this area.

## SUMMARY & REMARKS

The results of the plant trials using n-butanol and n-butanol-citric acid reagent systems as compared to the presently used Ultrawet D.S. system has indicated a marked superiority of these new systems.

The use of citric acid in the depression of chrysotile asbestos and other mineral species has been developed at Windsor Minerals in response to the potential need for a means to exclude extremely low levels of these contaminants from the finished product of the beneficiation process.

The use of these systems is strongly urged by this writer, to provide the protection against what are currently considered to be

materials presenting a severe health hazard and are potentially present in all talc ores in use at this time.

In closing, based on Windsor's knowledge of the physical chemistry of talc, and upon the results of all work performed to date, it is our strong belief that the use of these new reagent systems will not alter the salient consumer properties of the raw material supply or the finished baby powder sold under the Johnson and Johnson name.

Vernon Zeitz

Vernon Zeitz
Manager, Researsh and Development
Windsor Minerals Inc.
5/14/74

Table 2

## QUALITY ASSURANCE SAMPLING TEST RESULTS

| TIME | SAMPLE DESIGNATION | ACID INSOLUBLES (%) | COLOR REFLECTANCE (%) | pH | -325 m SCREEN (%) | BULK DENSITY ($lb./ft.^3$) | MAGNESIT (%) |
|---|---|---|---|---|---|---|---|
| 9:30 | ORE | 58.98 | 73.4 | | 90.93 | | |
| | TAILINGS | 28.32 | | | | | |
| | CLEANER CONCENTRATE | 99.05 | 88.0 | 7.57 | | | |
| | PRODUCT | 99.08 | 87.2 | 8.06 | 89.07 | 24.61 | .54 |
| 10:00 | ORE | 62.15 | 73.8 | | 90.40 | | |
| | TAILINGS | 25.84 | | | | | |
| | CLEANER CONCENTRATE | 98.94 | 87.3 | 7.78 | | | |
| | PRODUCT | 99.18 | 87.4 | 7.92 | 90.47 | 23.93 | .54 |
| 10:30 | ORE | 64.80 | 74.6 | | 90.05 | | |
| | TAILINGS | 24.95 | | | | | |
| | CLEANER CONCENTRATE | 98.94 | 87.1 | 7.79 | | | |
| | PRODUCT | 98.83 | 87.3 | 7.92 | 89.70 | 23.20 | .58 |
| 11:00 | ORE | 61.62 | 74.8 | | 90.09 | | |
| | TAILINGS | 26.26 | | | | | |
| | CLEANER CONCENTRATE | 98.80 | 87.3 | 7.81 | | | |
| | PRODUCT | 98.85 | 87.0 | 7.99 | 89.93 | 23.34 | .64 |
| 11:30 | ORE | 65.79 | 74.8 | | 89.86 | | |
| | TAILINGS | 26.40 | | | | | |
| | CLEANER CONCENTRATE | 98.76 | 87.2 | 8.42 | | | |
| | PRODUCT | 98.86 | 87.4 | 8.44 | 89.45 | 23.04 | .71 |
| 12:00 | ORE | 65.02 | 74.4 | | 90.38 | | |
| | TAILINGS | 28.86 | | | | | |
| | CLEANER CONCENTRATE | 98.97 | 87.3 | 8.19 | | | |
| | PRODUCT | 98.75 | 87.2 | 8.10 | 90.47 | 22.63 | .71 |

Table 2 Continued

| TIME | SAMPLE DESIGNATION | ACID INSOLUBLES (%) | COLOR REFLECTANCE (%) | pH | -325 m SCREEN (%) | BULK DENSITY ($lb./ft.^3$) | MAGNESITE (%) |
|---|---|---|---|---|---|---|---|
| 12:30 | ORE | 66.28 | 74.0 | | 89.15 | | |
| | TAILINGS | 24.13 | | | | | |
| | CLEANER CONCENTRATE | 98.54 | 86.3 | 8.19 | | | |
| | PRODUCT | 98.60 | 86.7 | 8.10 | 88.92 | 23.32 | .64 |
| 13:00 | ORE | 63.67 | 75.0 | | 90.10 | | |
| | TAILINGS | 28.82 | | | | | |
| | CLEANER CONCENTRATE | 98.49 | 86.4 | 7.89 | | | |
| | PRODUCT | 98.40 | 86.4 | 7.81 | 90.84 | 22.10 | .71 |
| 13:30 | ORE | 64.27 | 75.3 | | 90.01 | | |
| | TAILINGS | 23.37 | | | | | |
| | CLEANER CONCENTRATE | 98.56 | 86.9 | 6.38 | | | |
| | PRODUCT | 98.47 | 87.2 | 7.42 | 91.22 | 21.30 | .71 |
| 14:00 | ORE | 61.17 | 75,3 | | 90.66 | | |
| | TAILINGS | 26.05 | | | | | |
| | CLEANER CONCENTRATE | 98.78 | 87.3 | 5.28 | | | |
| | PRODUCT | 98.67 | 87.3 | 7.01 | 91.29 | 21.11 | .59 |
| 14:30 | ORE | 57.96 | 75.3 | | 89.92 | | |
| | TAILINGS | 24.27 | | | | | |
| | CLEANER CONCENTRATE | 98.67 | 87.1 | 4.64 | | | |
| | PRODUCT | 98.52 | 87.2 | 7.22 | 90.01 | 21.41 | .61 |
| 15:00 | ORE | 61.42 | 75.2 | | 89.62 | | |
| | TAILINGS | 23.69 | | | | | |
| | CLEANER CONCENTRATE | 98.69 | 87.5 | 4.38 | | | |
| | PRODUCT | 98.54 | 87.2 | 7.10 | 91.59 | 21.37 | .57 |

Table 2 Continued

| TIME | SAMPLE DESIGNATION | ACID INSOLUBLES (%) | COLOR REFLECTANCE (%) | pH | -325 m SCREEN (%) | BULK DENSITY ($lb./ft.^3$) | MAGNESI (%) |
|---|---|---|---|---|---|---|---|
| 15:30 | ORE | 62.63 | 75.2 | | 89.75 | | |
| | TAILINGS | 22.38 | | | | | |
| | CLEANER CONCENTRATE | 98.86 | 87.9 | 4.38 | | | |
| | PRODUCT | 98.66 | 87.5 | 6.92 | 90.37 | 21.56 | .53 |
| | ORE | | | | | | |
| | TAILINGS | | | | | | |
| | CLEANER CONCENTRATE | | | | | | |
| | PRODUCT | | | | | | |
| | ORE | | | | | | |
| | TAILINGS | | | | | | |
| | CLEANER CONCENTRATE | | | | | | |
| | PRODUCT | | | | | | |
| | ORE | | | | | | |
| | TAILINGS | | | | | | |
| | CLEANER CONCENTRATE | | | | | | |
| | PRODUCT | | | | | | |
| | ORE | | | | | | |
| | TAILINGS | | | | | | |
| | CLEANER CONCENTRATE | | | | | | |
| | PRODUCT | | | | | | |
| | ORE | | | | | | |
| | TAILINGS | | | | | | |
| | CLEANER CONCENTRATE | | | | | | |

Table 3

# LABORATORY REPORT

Date Produced 1/29/74

Product or Grade "66 U"

Sample No. or Description Ultrawet D.S. floated product

| TEST | FINDINGS | SPECIFIED |
|---|---|---|
| MOISTURE | .02 | N.M.T. 0.15% |
| TOTAL ACID SOLUBLE | 1.72 | N.M.T. 2.0% |
| MAGNESITE ($MgCO_3$) | .94 | N.M.T. 1.10% |
| COLOR | 86.0 | WHITE (BY STANDARD) |
| BULK DENSITY | 24.46 | 20.5 to 25.5 $lbs./ft.^3$ |
| COMPACTION | | |
| MAX. VOLUME | 146 cc | |
| MIN. VOLUME | 82 cc | |
| AVERAGE VOLUME | 114 cc | |
| SCREENS - 60 | 100.00 | 100% |
| - 100 | 100.00 | N.L.T. 99.7% |
| - 200 | 98.66 | N.L.T. 98.5% |
| - 325 | 85.55 | |
| TRACE ELEMENTS | | |
| ARSENIC | .13 | N.M.T. 2ppm. |
| HEAVY METALS | less than 10 | N.M.T. 10 ppm. |
| WATER SOLUBLE IRON | pass test | PASS TEST |
| MICROSCOPIC EXAMINATION | pass test | PASS TEST |
| pH | 8.89 | |

Table 4

# LABORATORY REPORT

Date Produced 1/29/74

Product or Grade "66 A"

Sample No. or Description N-butanol floated product

| TEST | FINDINGS | SPECIFIED |
|---|---|---|
| MOISTURE | .03 | N.M.T. 0.15% |
| TOTAL ACID SOLUBLE | 1.32 | N.M.T. 2.0% |
| MAGNESITE ($MgCO_3$) | .72 | N.M.T. 1.10% |
| COLOR | 87.0 | WHITE (BY STANDARD) |
| BULK DENSITY | 22.40 | 20.5 to 25.5 $lbs./ft.^3$ |
| COMPACTION | | |
| MAX. VOLUME | 130 cc | |
| MIN. VOLUME | 94 cc | |
| AVERAGE VOLUME | 112 cc | |
| SCREENS - 60 | 100.00 | 100% |
| - 100 | 100.00 | N.L.T. 99.7% |
| - 200 | 98.99 | N.L.T. 98.5% |
| - 325 | 91.27 | |
| TRACE ELEMENTS | | |
| ARSENIC | .07 | N.M.T. 2ppm. |
| HEAVY METALS | less than 10 | N.M.T. 10 ppm. |
| WATER SOLUBLE IRON | pass test | PASS TEST |
| MICROSCOPIC EXAMINATION | pass test | PASS TEST |
| pH | 8.47 | |

Table 5

# LABORATORY REPORT

Date Produced 1/29/74

Product or Grade "66 AC"

Sample No. or Description N-butanol, citric acid floated product

| TEST | FINDINGS | SPECIFIED |
|---|---|---|
| MOISTURE | .02 | N.M.T. 0.15% |
| TOTAL ACID SOLUBLE | 1.23 | N.M.T. 2.0% |
| MAGNESITE ($MgCO_3$) | .66 | N.M.T. 1.10% |
| COLOR | 87.4 | WHITE (BY STANDARD) |
| BULK DENSITY | 21.64 | 20.5 to 25.5 lbs./ft.$^3$ |
| COMPACTION | | |
| MAX. VOLUME | 140 cc | |
| MIN. VOLUME | 100 cc | |
| AVERAGE VOLUME | 120 cc | |
| SCREENS - 60 | 100.00 | 100% |
| - 100 | 100.00 | N.L.T. 99.7% |
| - 200 | 99.15 | N.L.T. 98.5% |
| - 325 | 91.97 | |
| TRACE ELEMENTS | | |
| ARSENIC | .17 | N.M.T. 2ppm. |
| HEAVY METALS | less than 10 | N.M.T. 10 ppm. |
| WATER SOLUBLE IRON | pass test | PASS TEST |
| MICROSCOPIC EXAMINATION | pass test | PASS TEST |
| pH | 7.64 | |

Table 6

COMPARITIVE TALC RECOVERIES DURING REAGENT TRIAL PERIOD

| | Ultrawet D.S. | n-butanol | n-butanol citric acid |
|---|---|---|---|
| H | 67.05 | 63.54 | 61.49 |
| T | 40.15 | 26.70 | 23.95 |
| C | 98,08 | 98.80 | 98.71 |
| % RECOVERY | 67.93 | 79.45 | 80.61 |
| % CHANGE VS. ULTRAWET COLLECTION PERIOD | 0 | +16.97 | +18.67 |

H=% acid insoluble content of ore
T=% acid insoluble content of tailings
C=% acid insoluble content of cleaner concentrate

Table 7

## OVERSIZE COUNT

Number percent particle size distribution of

"66 U"-Ultrawet D.S. Floated Talc 1/29/74

| SIZE (microns) | NUMBER | % GREATER THAN STATED SIZE |
|---|---|---|
| 1.0 | 4113 | 100.00 |
| 2.5 | 3712 | 90.25 |
| 5.0 | 2431 | 59.11 |
| 10 | 1106 | 26.89 |
| 15 | 556 | 13.52 |
| 20 | 297 | 7.22 |
| 30 | 79 | 1.92 |
| 40 | 36 | .88 |
| 50 | 12 | .29 |
| 60 | 2 | .05 |

9.75

MEAN SIZE = 8.62 microns

Note:

Limiting Detection Threshold = 2.0 microns

Figure 1

NUMBER PERCENT PARTICLE SIZE DISTRRIBUTION BY OVERSIZE COUNT OF "66 U"- Ulrawet D.S. Floated Talc 1/29/74

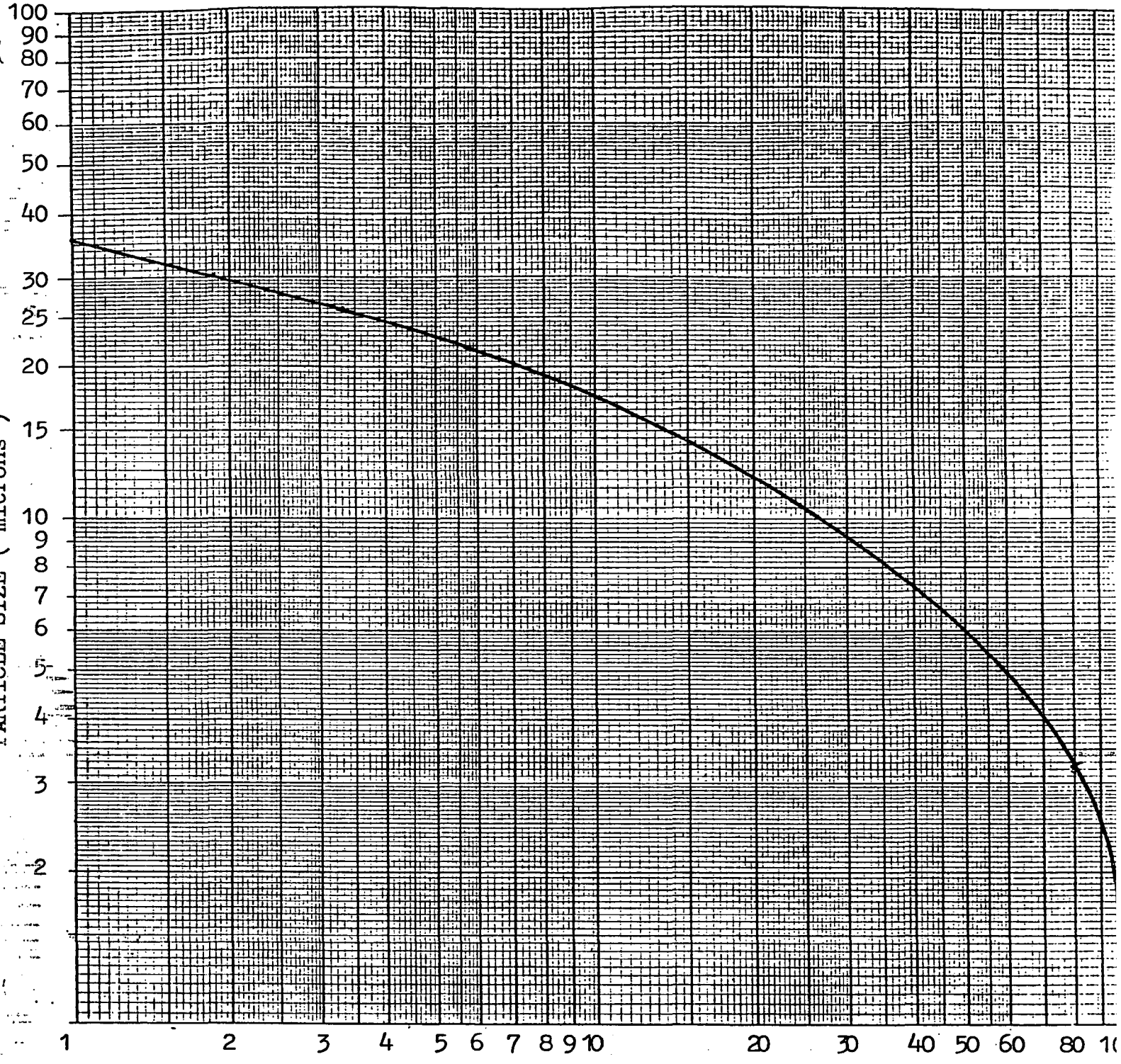


Table 8

## OVERSIZE COUNT

Number percent particle size distribution of

"66 A"- Butanol Floated Talc 1/29/74

| SIZE (microns) | NUMBER | % GREATER THAN STATED SIZE |
|---|---|---|
| 1.0 | 4399 | 100.00 |
| 2.5 | 4139 | 94.08 |
| 5.0 | 2836 | 64.46 |
| 10 | 1323 | 30.07 |
| 15 | 757 | 17.20 |
| 20 | 401 | 9.11 |
| 30 | 126 | 2.86 |
| 40 | 41 | .93 |
| 50 | 14 | .31 |
| 60 | 3 | .06 |

} 5.0μ

MEAN SIZE = 9.39 microns

Note:

Limiting Detection Threshold = 2.0 microns

Figure 2

NUMBER PERCENT PARTICLE SIZE DISTRRIBUTION BY OVERSIZE COUNT OF "66 A"- N-butanol Floated talc 1/29/74

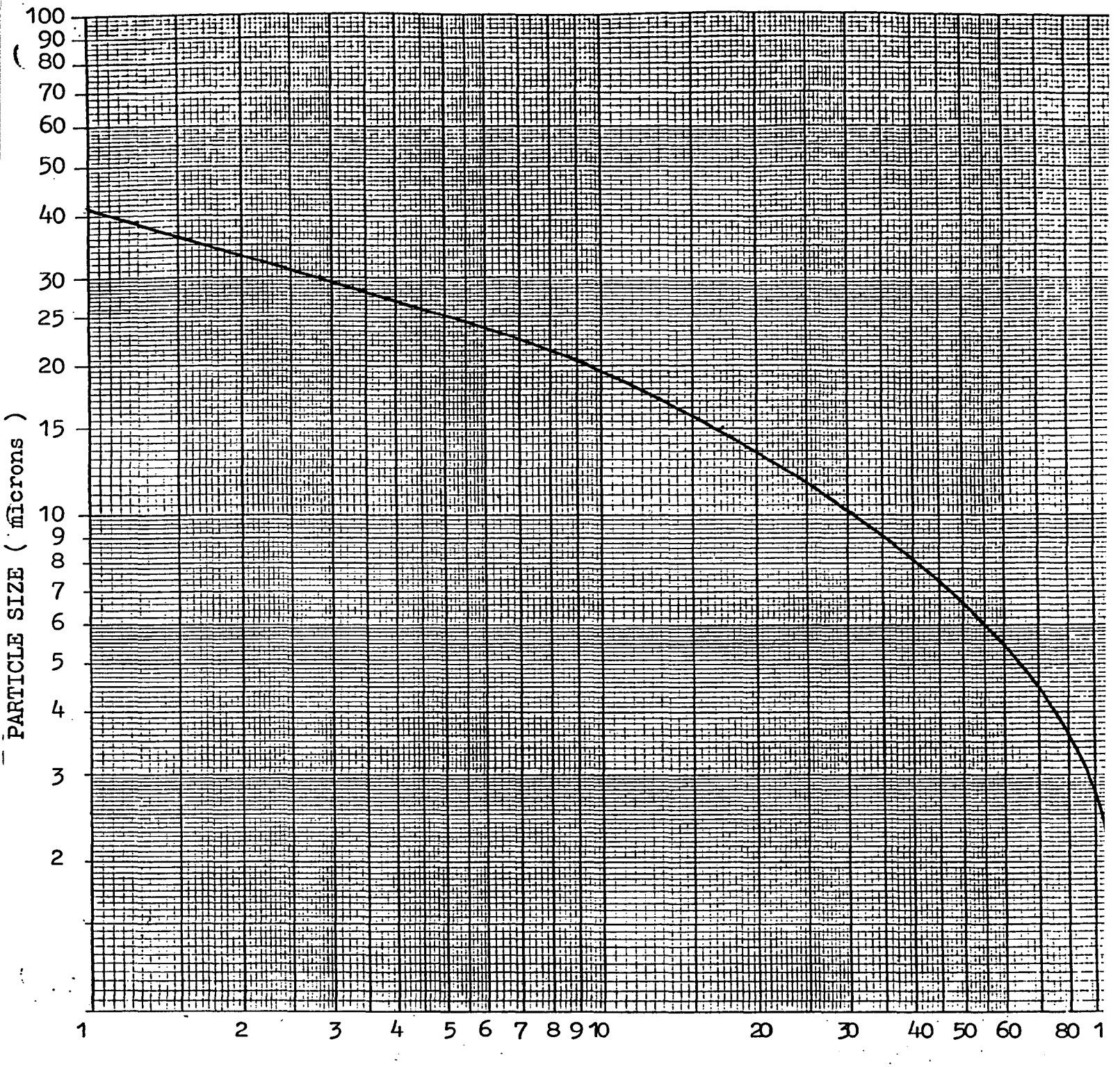


Table 9

## OVERSIZE COUNT

Number percent particle size distribution of

"66 AC"- Butanol, Citric Acid Floated Talc 1/29/74

| SIZE (microns) | NUMBER | % GREATER THAN STATED SIZE |
|---|---|---|
| 1.0 | 4035 | 100.00 |
| 2.5 | 4003 | 99.20 |
| 5.0 | 3105 | 76 95 |
| 10 | 1632 | 40.44 |
| 15 | 863 | 21.38 |
| 20 | 513 | 12.71 |
| 30 | 160 | 3.96 |
| 40 | 53 | 1.31 |
| 50 | 12 | .29 |
| 60 | 8 | .19 |

} 0.8

MEAN SIZE = 11.08 microns

Note:

Limiting Detection Threshold = 2.0 microns

Figure 3

NUMBER PERCENT PARTICLE SIZE DISTRRIBUTION BY OVERSIZE COUNT OF "66 AC"- N-butanol, Citric Acid Floated talc 1/29/74

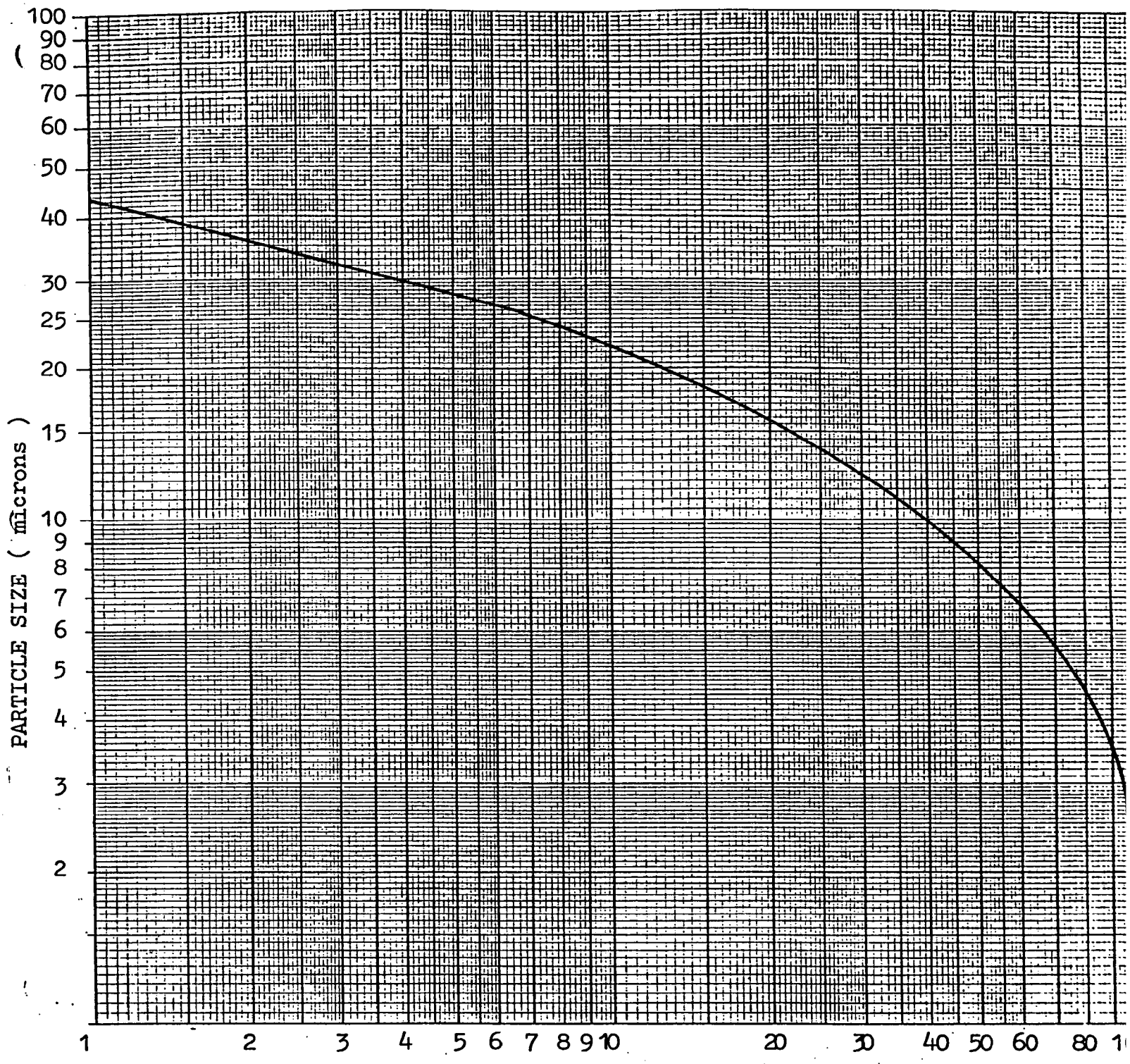


Table 10

Weight percent particle size distribution
by Andreasen Sedimentation Pipette
of Ulrawet Floated Grade"66 U" Production Talc 1/29/74

| Time (min.) | Height (cm) | Wt. (mg) | Equivalent spherical diameter(microns) | Percent less than stated size |
|---|---|---|---|---|
| 2 | 20.50 | 89.3 | 43.0 | 87.3 |
| 4 | 20.08 | 72.1 | 30.1 | 70.1 |
| 6 | 19.66 | 52.1 | 24.3 | 50.1 |
| 30 | 19.24 | 20.0 | 10.8 | 18.0 |
| 60 | 18.82 | 12.0 | 7.5 | 10.0 |
| 90 | 18.40 | 9.2 | 6.1 | 7.2 |
| 130 | 17.98 | 7.4 | 5.0 | 5.4 |

| Particle Size in Microns (Equivalent Spherical Diameter) | | Percent by weight |
|---|---|---|
| Less Than | Greater Than | |
| | 43.0 | 12.7 |
| 43.0 | 30.1 | 17.2 |
| 30.1 | 24.3 | 20.0 |
| 24.3 | 10.8 | 32.1 |
| 10.8 | 7.5 | 8.0 |
| 7.5 | 6.1 | 2.8 |
| 6.1 | 5.0 | 1.8 |
| 5.0 | | 5.4 |

Figure 4

PARTICLE SIZE DISTRIBUTION
BY ANDREASEN PIPETTE OF ULRAWET FLOATED GRADE "66 U"
PRODUCTION TALC 1/29/74

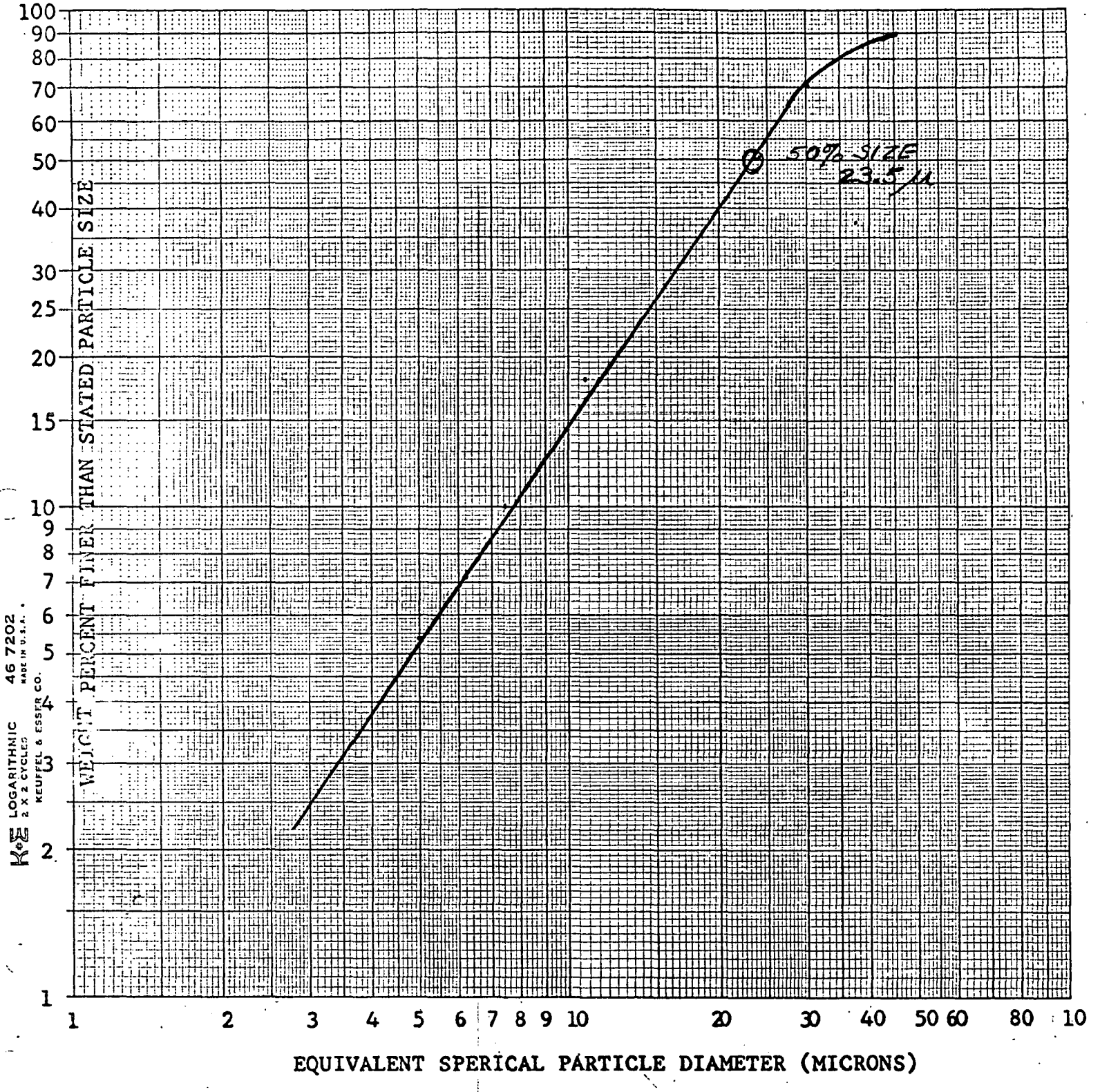


Figure 5

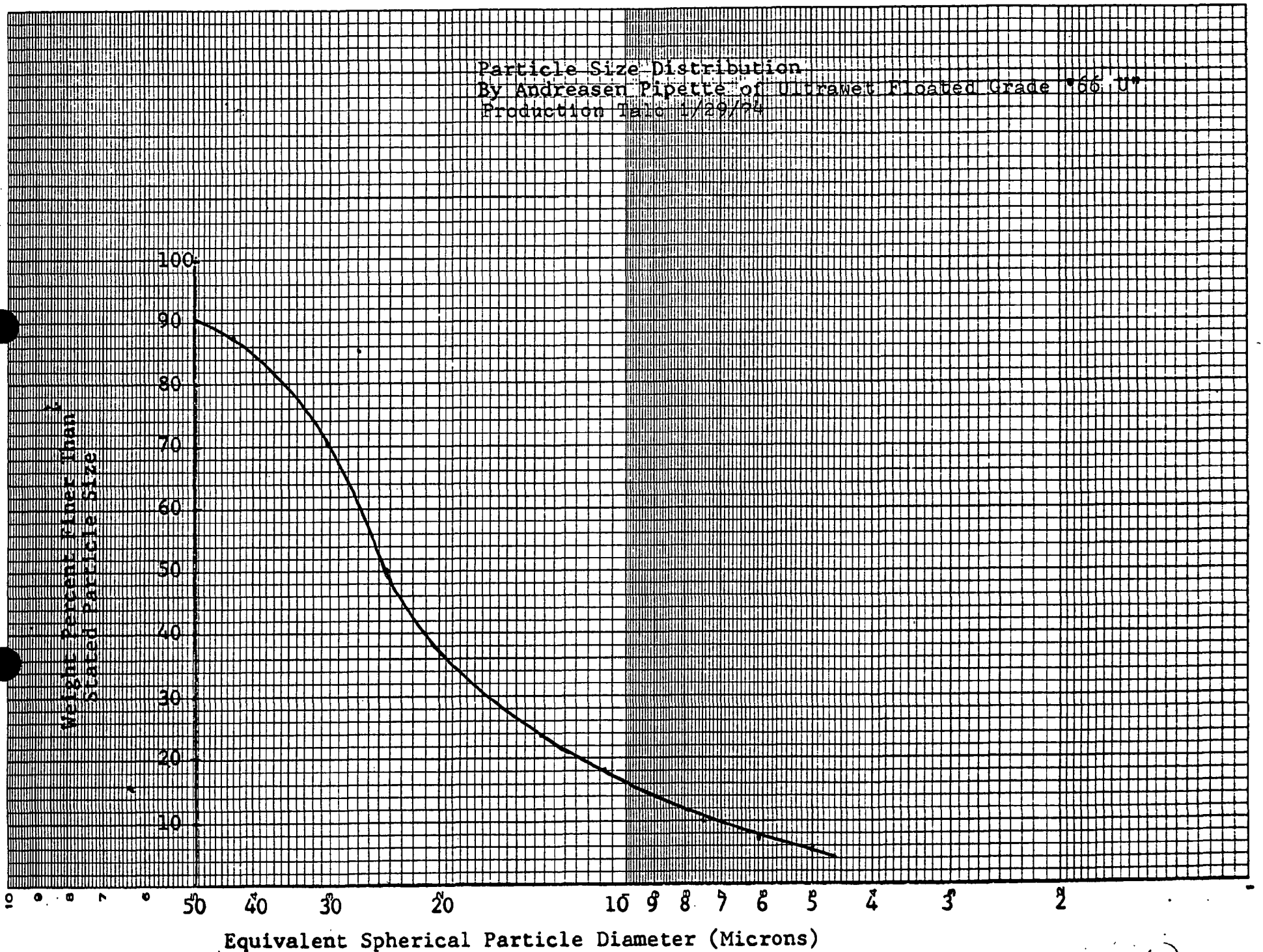


Table 11

Weight percent particle size distribution
by Andreasen Sedimentation Pipette
of Butanol Floated Grade "66A" Production Talc 1/29/74

| Time (min.) | Height (cm) | Wt. (mg) | Equivalent spherical diameter(microns) | Percent less than stated size |
|---|---|---|---|---|
| 2 | 20.50 | 88.6 | 43.0 | 86.6 |
| 4 | 20.08 | 73.9 | 30.1 | 71.9 |
| 6 | 19.66 | 61.8 | 24.3 | 59.8 |
| 30 | 19.24 | 23.6 | 10.8 | 21.6 |
| 60 | 18.82 | 14.7 | 7.5 | 12.7 |
| 90 | 18.40 | 11.7 | 6.1 | 9.7 |
| 130 | 17.98 | 9.1 | 5.0 | 7.1 |

| Particle Size in Microns (Equivalent Spherical Diameter) | | Percent by weight |
|---|---|---|
| Less Than | Greater Than | |
| | 43.0 | 13.4 |
| 43.0 | 30.1 | 14.7 |
| 30.1 | 24.3 | 12.1 |
| 24.3 | 10.8 | 38.2 |
| 10.8 | 7.5 | 8.9 |
| 7.5 | 6.1 | 3.0 |
| 6.1 | 5.0 | 2.6 |
| 5.0 | | 7.1 |

Figure 6

PARTICLE SIZE DISTRIBUTION
BY ANDREASEN PIPETTE OF BUTANOL FLOATED GRADE "66A"
PRODUCTION TALC 1/29/74

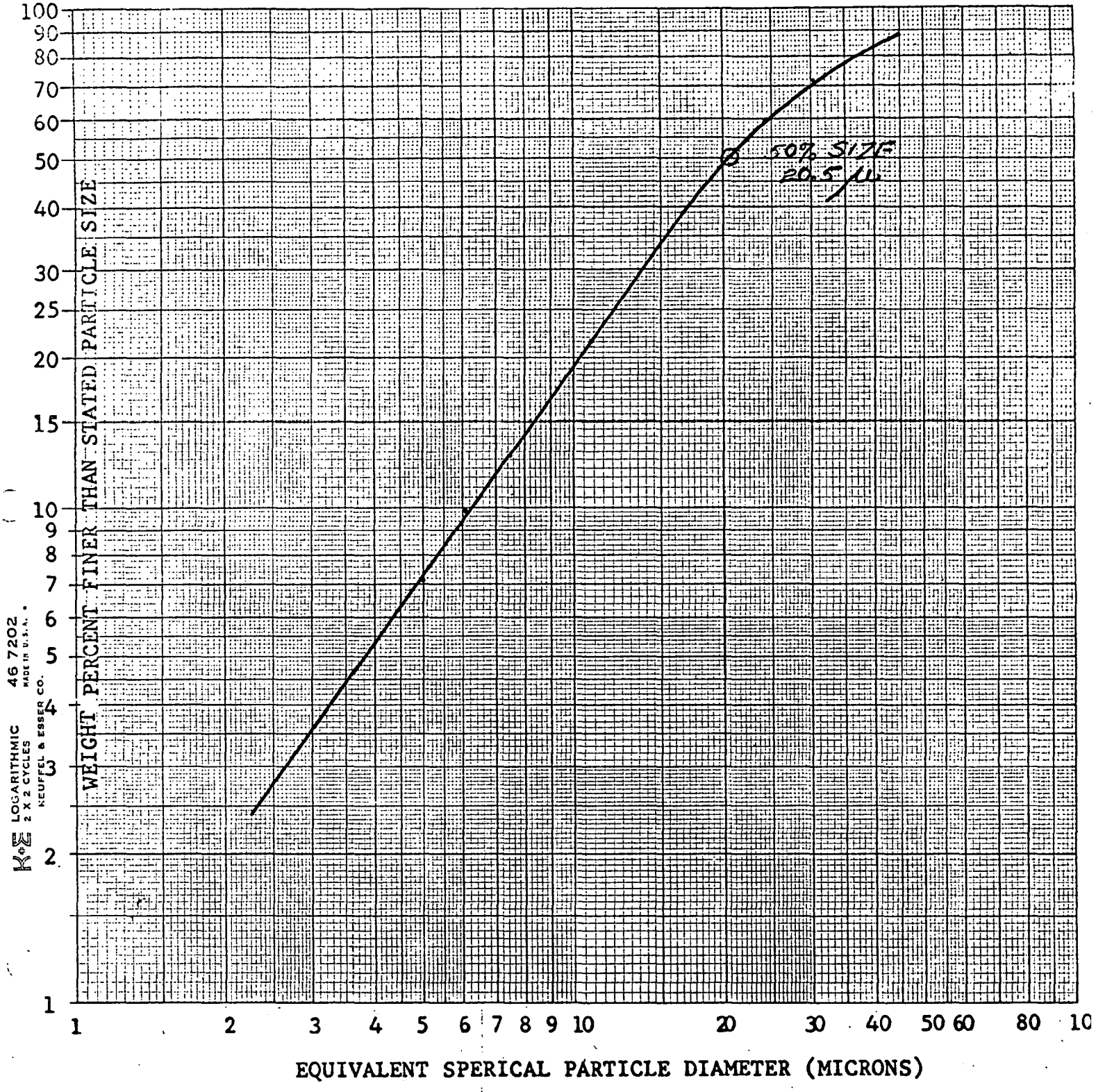


Figure 7

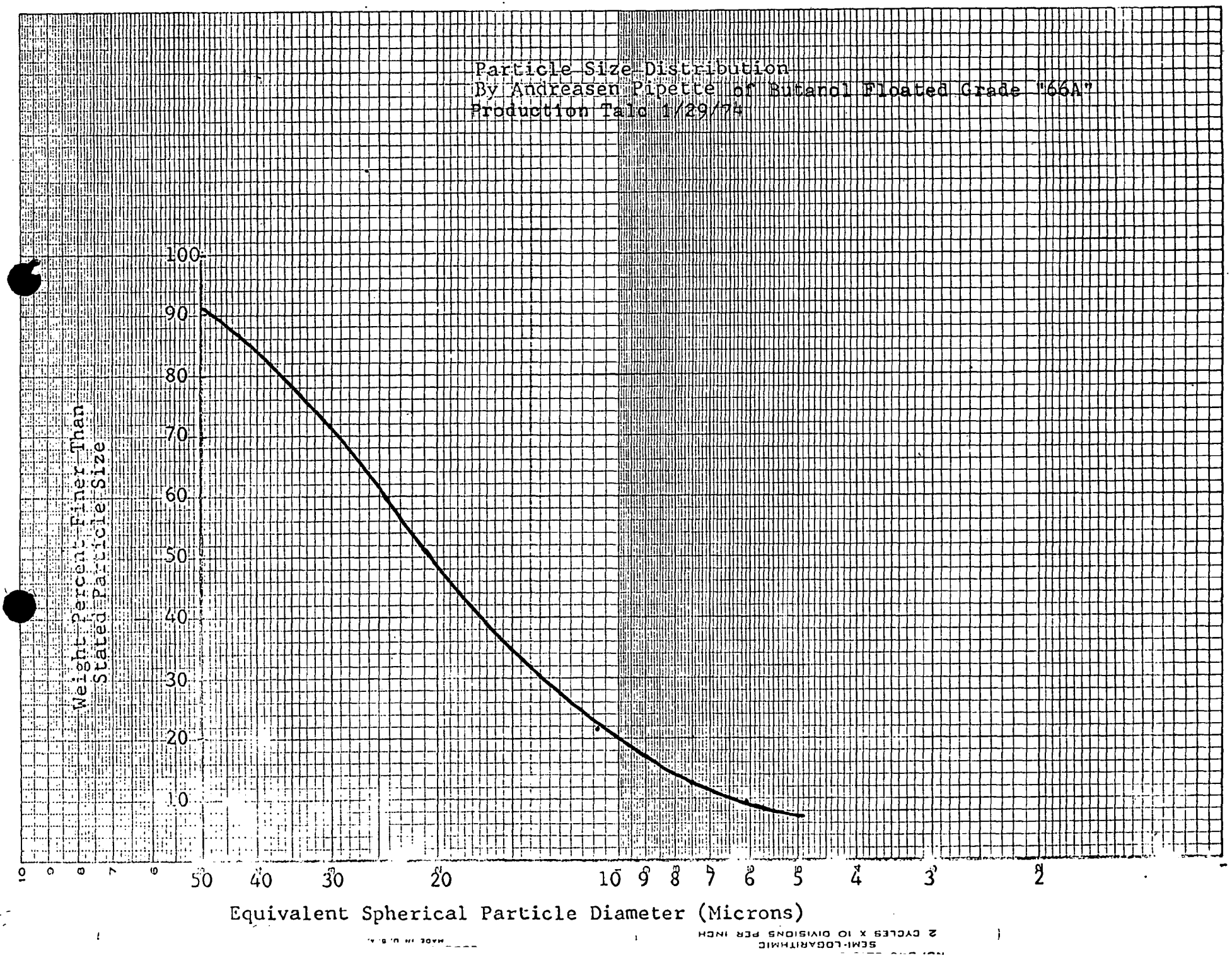


Table 12

Weight percent particle size distribution
by Andreasen Sedimentation Pipette
of Butanol-Citric Floated Grade "66AC" Production Talc 1/29/74

| Time (min.) | Height (cm) | Wt. (mg) | Equivalent spherical diameter(microns) | Percent less than stated size |
|---|---|---|---|---|
| 2 | 20.50 | 90.7 | 43.0 | 88.7 |
| 4 | 20.08 | 77.9 | 30.1 | 75.9 |
| 6 | 19.66 | 63.2 | 24.3 | 61.2 |
| 30 | 19.24 | 26.1 | 10.8 | 24.1 |
| 60 | 18.82 | 16.9 | 7.5 | 14.9 |
| 90 | 18.40 | 12.9 | 6.1 | 10.9 |
| 130 | 17.98 | 10.1 | 5.0 | 8.1 |

| Particle Size in Microns (Equivalent Spherical Diameter) | | Percent by weight |
|---|---|---|
| Less Than | Greater Than | |
| | 43.0 | 11.3 |
| 43.0 | 30.1 | 12.8 |
| 30.1 | 24.3 | 14.7 |
| 24.3 | 10.8 | 37.1 |
| 10.8 | 7.5 | 9.2 |
| 7.5 | 6.1 | 4.0 |
| 6.1 | 5.0 | 2.8 |
| 5.0 | | 8.1 |

Figure 8

PARTICLE SIZE DISTRIBUTION
BY ANDREASEN PIPETTE OF BUTANOL-CITRIC FLOATED GRADE "66AC"
PRODUCTION TALC 1/29/74

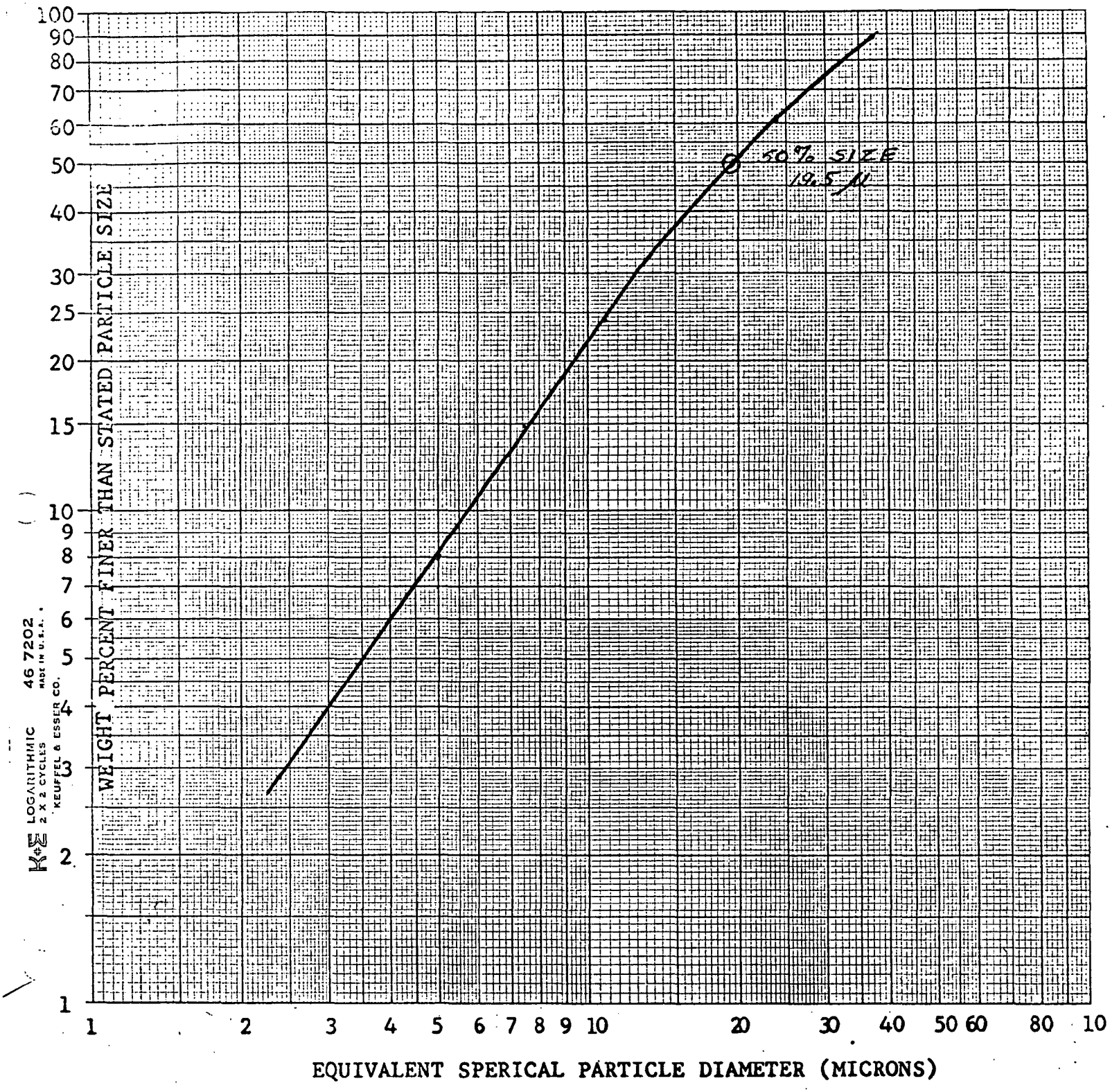


Figure 9

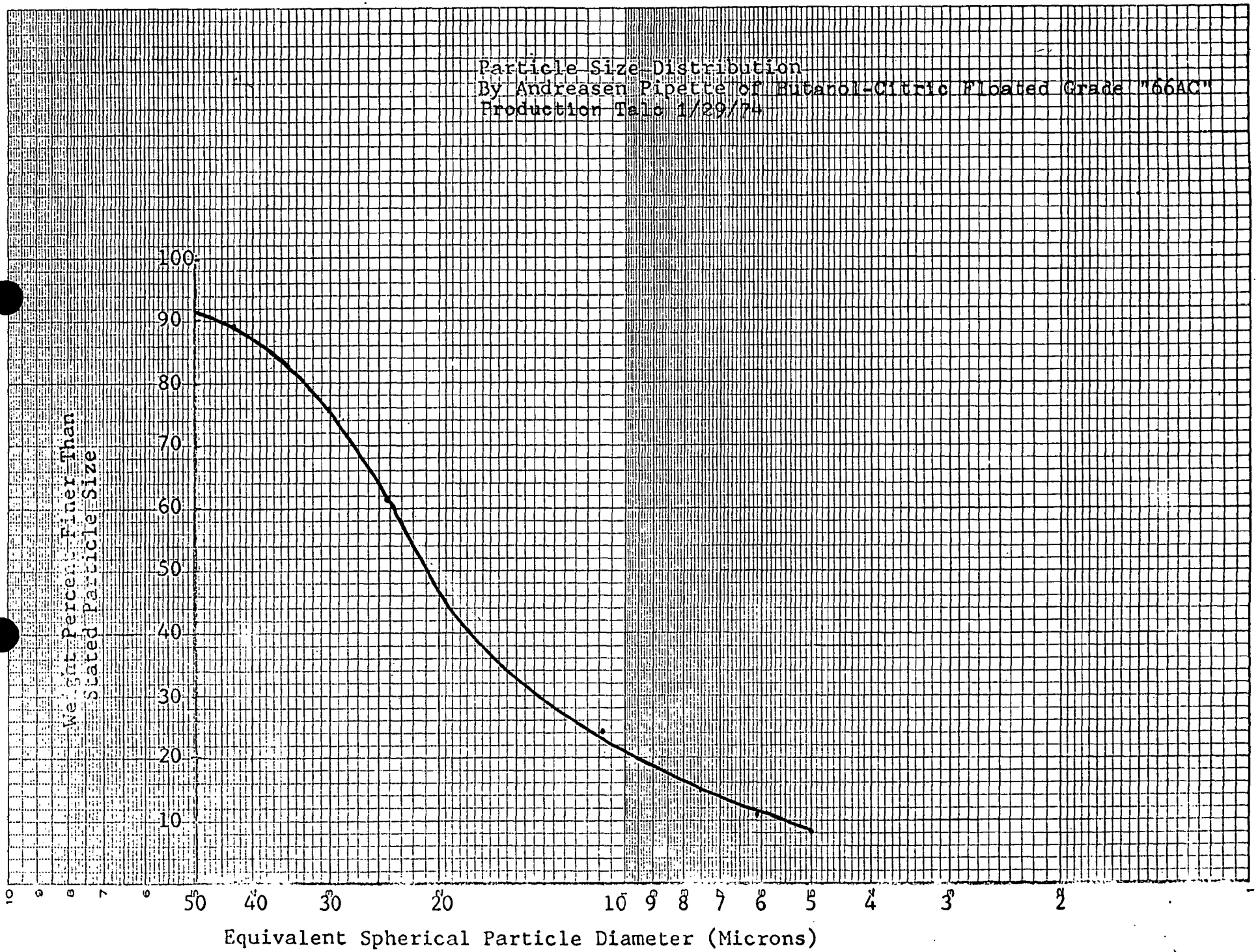


Table 13

AMPHIBOLE CONTENT OF REAGENT TRIAL PROCESS SAMPLES

| Sample designation | Amphibole level (ppm) |
|---|---|
| A ore | 3000 |
| A product | 100-200 |
| B ore | 3000 |
| B product | 100-200 |
| C ore | 3000 |
| C product | 100-200 |

LEGEND:

A- Ulrawet D.S. trial period
B- N-butanol trial period
C- N-butanol-citric acid trial period

Table 14

Relative amounts of chlorite, dolomite, and magnesite with respect to talc

| | Chlorite/Talc | Dolomite/Talc | Magnesite/Talc |
|---|---|---|---|
| ORE A | $7.0 \times 10^{-2}$ | 0.12 | 0.27 |
| ORE B | $8.6 \times 10^{-2}$ | 0.11 | 0.23 |
| ORE C | $7.4 \times 10^{-2}$ | 0.11 | 0.25 |
| PRODUCT A | $10 \times 10^{-3}$ | very small | very small |
| PRODUCT B | $8.6 \times 10^{-3}$ | very small | very small |
| PRODUCT C | $8.5 \times 10^{-3}$ | very small | very small |
| TAILS A | 0.28 | 0.78 | 1.2 |
| TAILS B | 2.6 | 5.7 | 11 |
| TAILS C | 2.4 | 6.0 | 12 |

LEGEND:

A- Ultrawet D.S. trial period
B- N-butanol trial period
C- N-butanol-citric acid trial period

Figure 10

X-RAY DIFFRACTION PATTERNS OF REAGENT TRIAL TALC PROCESS SAMPLES

A- Ultrawet D.S. trial period
B- n-butanol trial period
C- n-butanol trial period

C- chlorite
T- talc
D- dolomite
M- magnesite

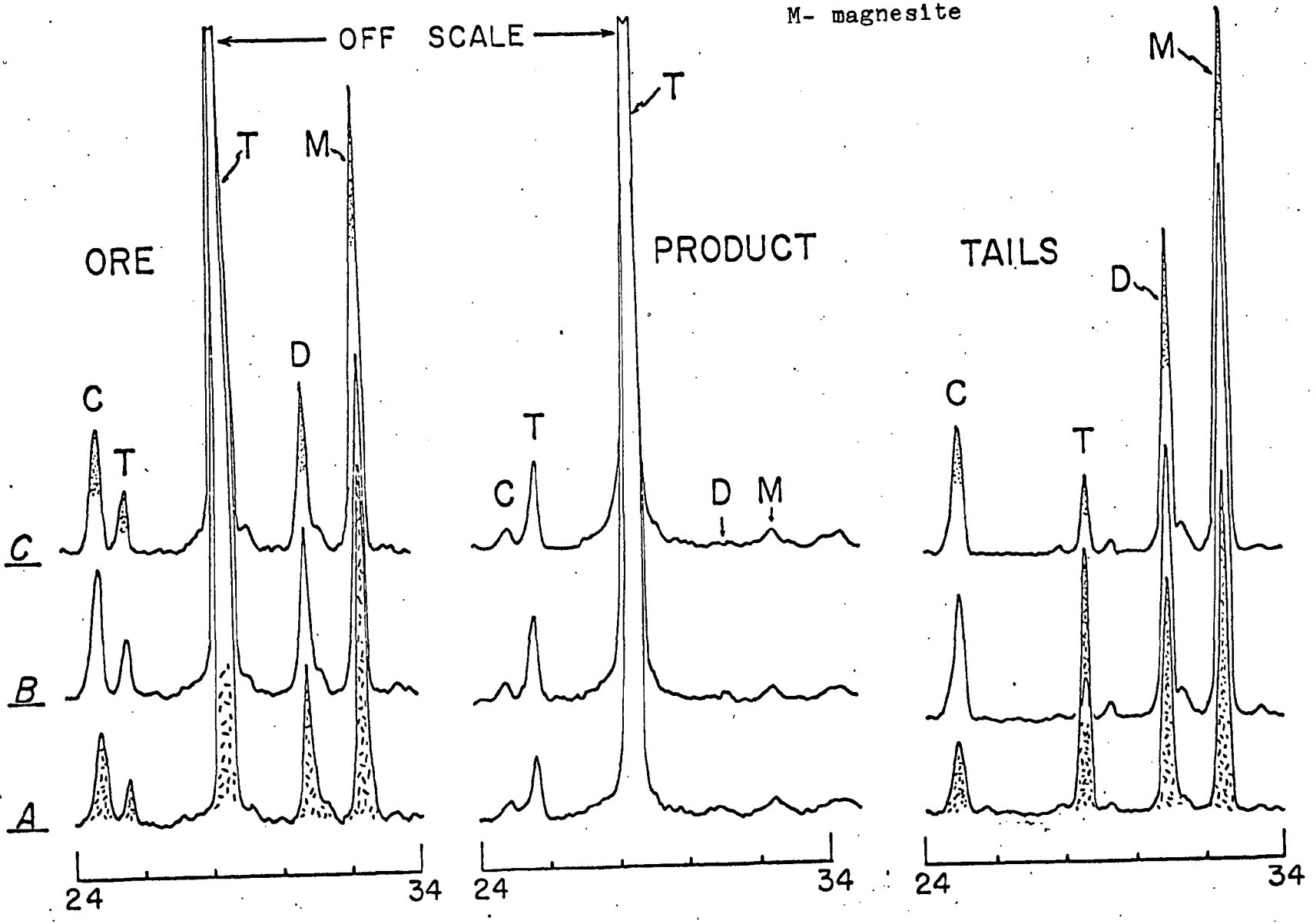
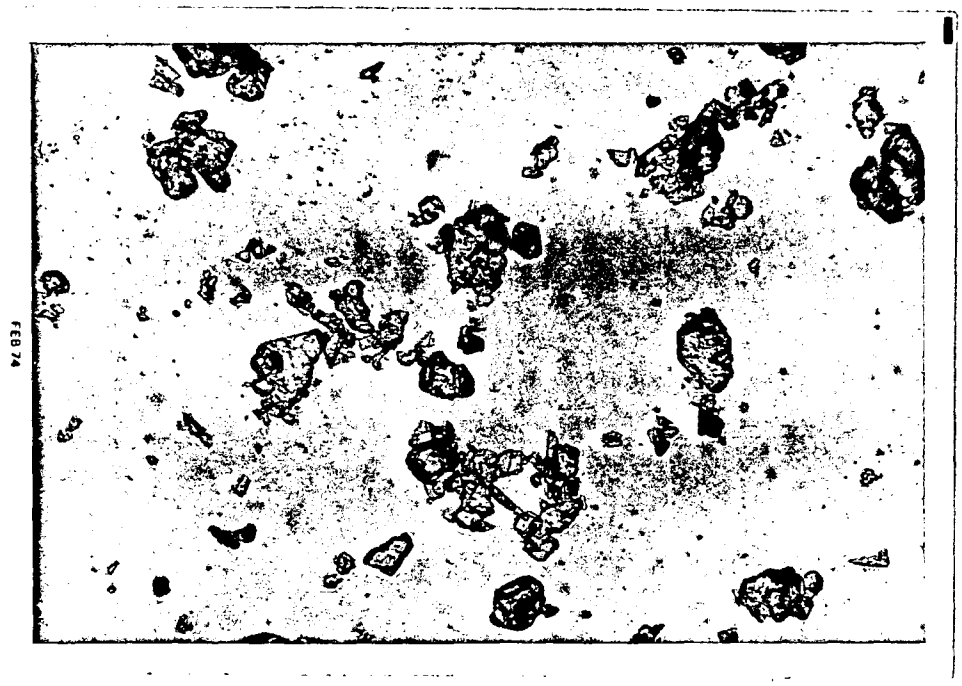


Figure 11

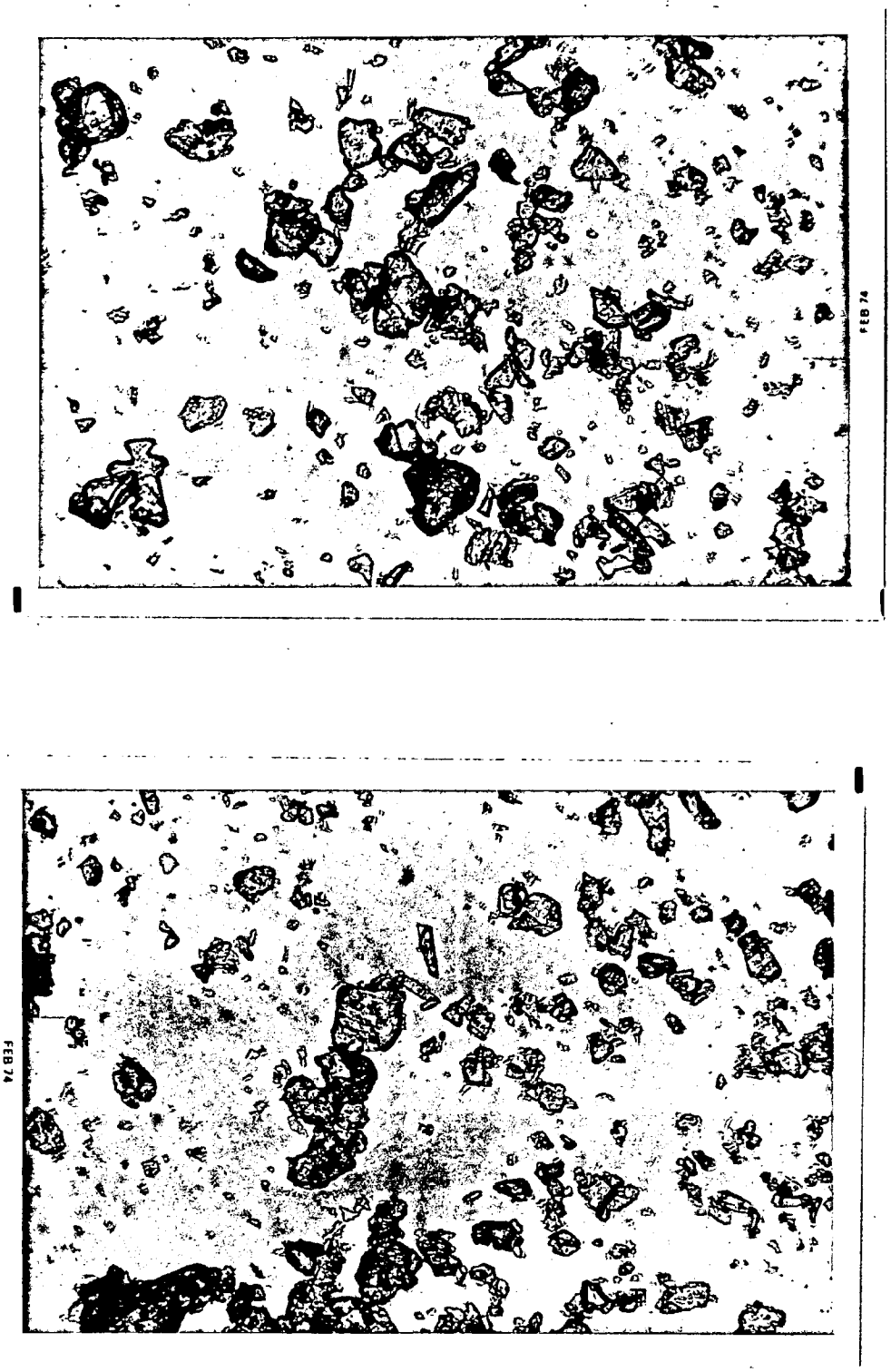
PHOTOMICROGRAPHY OF "66 U"- Ultrawet D.S. Floated Product


Magnification- 100X

Figure 12

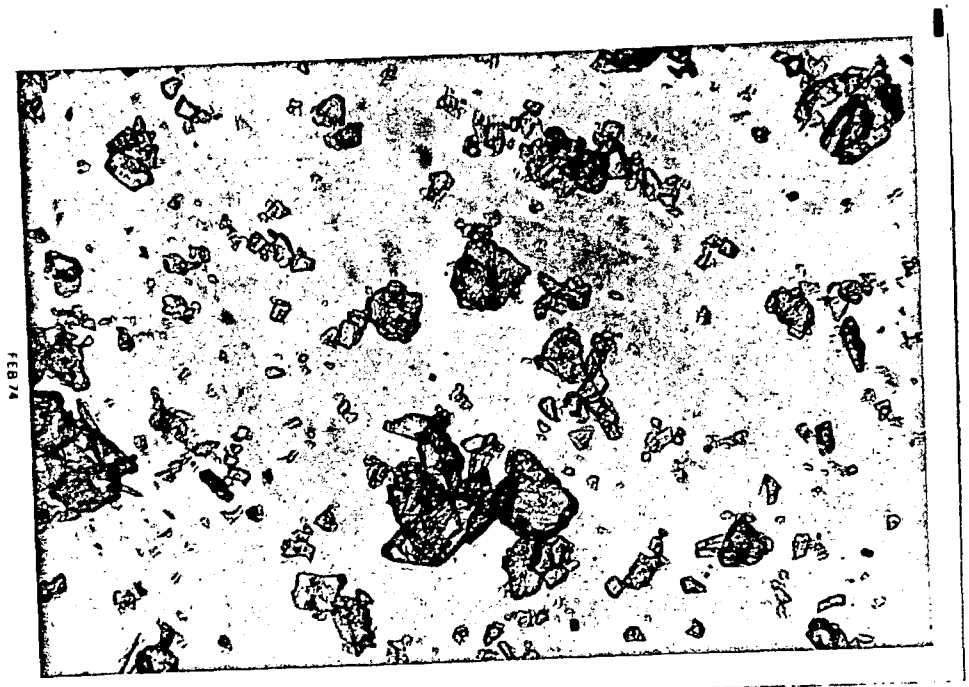
PHOTOMICROGRAPHY OF "66 A"- N-butanol Floated Product

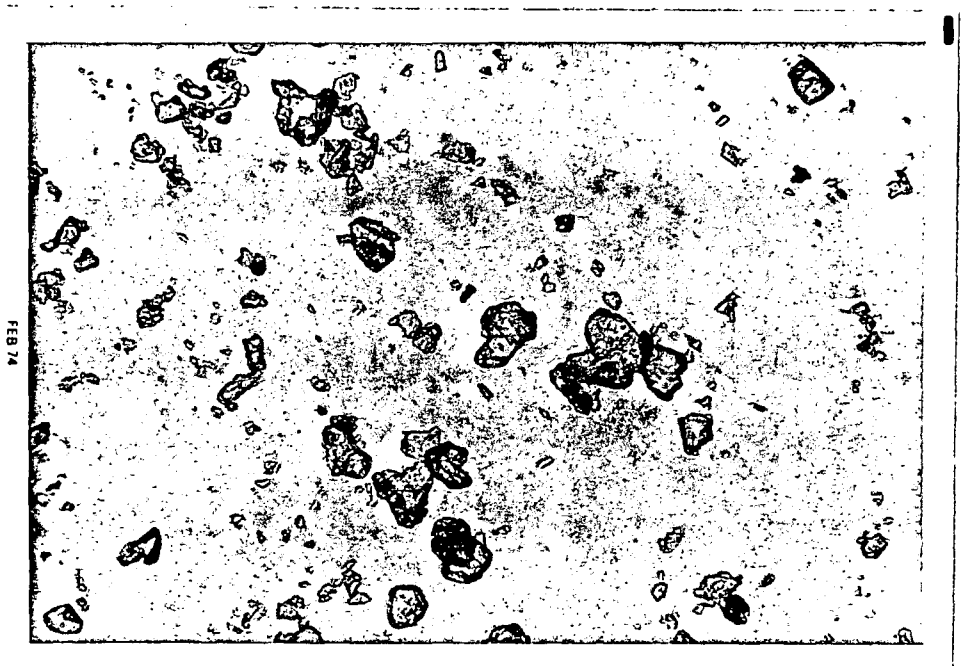


Magnification- 100X

Figure 13

PHOTOMICROGRAPHY OF "66AC"- N-butanol Floated Product




Magnification- 100X

Table 15

ASBESTIFORM FIBER COUNTS BY WALTER C. MC CRONE ASSOCIATES

| Sample designation | Fiber count per E.M. grid | Fiber identification |
|---|---|---|
| 66-U-Ore | 0 | |
| 66-U-Product | 1 | Probably chrysotile |
| 66-A-Ore | 1 | Probably chrystile |
| 66-A-Product | 0 | |
| 66-AC-Ore | 8 | Chrysotile |
| 66-AC-Product | 1 | Chrysotile |

LEGEND:

66-U- Time period using Ultrawet D.S.
66-A- Time period using n-butanol
66-AC- Time period using n-butanol-citric acid

ATTACHMENT B

# ASBESTIFORM DEPRESSION

# THROUGH THE USE OF

# NEW FLOATATION REAGENT SYSTEMS

INTRODUCTION:

A study was performed at Windsor Minerals to quantify the effectiveness of two new floatation reagent systems in the depression of asbestiform minerals in the floatation process. Analysis of the floated products was accomplished using a Millipore ΤΤMC Image Analyzer as the analytical detection device.

CONCLUSIONS:

1. A combination of n-butyl alcohol as a frother along with citric acid as a depressive agent proved to be 20 times as effective as Ultrawet D.S. suppressing asbestiforms in the final product.

2. Using only n-butyl alcohol as a frother proved to be 7 times as effective as Ultrawet D.S. in suppressing asbestiforms.

3. Ultrawet D.S. provided only a minimal suppression of asbestiforms through the floatation process.

EXPERIMENTAL:

Ground ore from the Hammondsville Mine was "doped" with 1.0% by weight of the fibrous form of anthophylite which occurs as a rare mineral in the Hammondsville ore body, and subjected to a series of laboratory floatations using the following reagent systems:

1. Ultrawet D.S.

2. n-butyl alcohol

3. n-butyl alcohol-citric acid.

The products obtained from these laboratory floatations were scanned on a video monitor coupled to an optical microscope, the system having a useful magnification of 500X. Clearly recognizable asbestiform anthophylite was counted and totalized over 100 viewed fields. The number of particles viewed in the 100 fields were totalized by means of a complementary computer interfaced to the system. The numbers obtained by this technique were compared to those obtained by an identical analysis of a standard preparation consisting of a Grade "66" product "doped" with 2.0% by weight of fibrous anthophylite.

RESULTS:

Table 1 gives the data and calculated numerical relationships devised to indicate the effectiveness of the new reagent systems in the depression of fibrous anthophylite. These relationships, their value and definitions are as follows:

1. Rejection factor: a relationship derived to indicate the weight rejection of anphophylite using a given reagent system. This relationship is arrived at by comparing the anthophylite weight percentage in the floated product to the 2.0% asbestiform "doped" product which represents a floated material having undergone no rejection of asbestiforms from the ore to the product.

The Rejection Factor is defined in these experiments for a given floatation reagent as: $\frac{2.0}{\text{anthophylite weight percentage in floated product}}$

2. Rejection Ratio - This term relates the effectiveness of suppression of asbestiforms by the alcohol based systems, to the existing Ultrawet D.S. system and is defined as follows:

$$\text{Rejection Ratio} = \frac{\text{Rejection Factor of new reagent system}}{\text{Rejection Factor of Ultrawet D.S. system}}$$

Table I Asbestiform Analysis of Cosmetic Grade Talcs Using TTMC Image Analyzer.

| | 2.0% Asbestiform Containing Product | Ultrawet D.S. Floated Product | N-Butyl Alcohol Floated Product | N-Butyl Alcohol Citric Acid Floated Product |
|---|---|---|---|---|
| Total Fields Counted | 100 | 100 | 100 | 100 |
| Total Fibers Counted | 298 | 37 | 6 | 2 |
| Total Particles Counted | 10681 | 9166 | 11416 | 10103 |
| Weight Percentage Asbestiform | 2.00 | .2894 | .0377 | .0142 |
| Rejection Factor | 1.00 | 6.91 | 53.08 | 140.94 |
| Rejection Ratio | -- | 1.00 | 7.68 | 20.39 |

SUMMARY AND REMARKS:

The data shows a profound influence of the alcohol based reagent system upon the amounts of asbestiforms reporting in the floated product. It is apparent that the system which includes citric acid is more effective than n-butanol alone.

Although the data was accumulated for the specific mineral species, fibrous anthophylite, the same results can be predicted for other fibrous amphibole minerals and chrysotile asbestos found in association with the Hammondsville ore body whose surfaces expose a substantial concentration of magnesium and hydroxl groups as reactive sites.

ATTACHMENT C

MINEROLOGY OF ORES, PRODUCTS AND MILL TAILS RE DIFFERENT FLOATATION REAGENTS

TO: WINDSOR MINERALS INC., Windsor, Vermont 05089

FROM: R. C. Reynolds, Jr., Department of Earth Sciences
Dartmouth College, Hanover, N.H. 03755

SUBJECT: Mineralogy of Ores, Products and Mill Tails Re Different Flotation Reagents

INTRODUCTION:

A study was made of the mineralogy of talc products and mill tails that were produced by the use of three different flotation schemes. The designations and descriptions used in this report are as follows:

| Flotation Agent | Designation |
|---|---|
| Ultrawet | A |
| Butanol | B |
| Butanol + Citric Acid | C |

In addition, studies were made of the ore that produced each of the products and mill tails.

TECHNIQUE:

Ores, products, and tails were analyzed by x-ray diffraction methods. Copper $K_\alpha$ radiation was used and the region $2\theta = 24$ to $2\theta = 34°$ was scanned. This $2\theta$ region contains important peaks from talc, chlorite, dolomite and magnesite. Examples of runs are shown on Figure 1. The data in Table 1 was obtained by averaging peak heights from three scans of each sample.

Materials were studied for amphiboles by means of the heavy-liquid-benzethonium chloride method described in the Windsor Mineral Report of March, 1974. To improve separation and subsequent semi-quantitative estimation of amphibole, product samples were spiked with dolomite and tourmaline, sized 10-40μ, to better simulate the ores, which behave well in the amphibole separation procedure.

RESULTS:

Figure 1 shows the x-ray diffraction patterns of ores, products, and tails associated with each of the flotation procedures. Peaks are labelled C = chlorite, T = Talc, D = dolomite, and M = magnesite. The results clearly show

(1) the low chlorite, magnesite, and dolomite in all of the products

(2) the large amounts of magnesite, dolomite, and chlorite in ores and tails

(3) the low concentration of talc in tails B and C

Ores A, B and C are similar as are products A, B and C. The only significant difference among the three treatments shows in the tails; those from treatment A (ultrawet) clearly have a much large talc content than do the tails from the butanol or the butanol-citric acid experiment.

Table 1 shows data tabulated from repeated (three times) runs similar to those shown on Figure 1. The values are meaningful only in a relative sense. There appear to be no significant differences among ores A, B and C, and products A, B and C.

The major difference is among the tails, where tails A is clearly much richer in talc than tails B or tails C.

It is concluded that:

(1) The ores used for the three flotation experiments are very similar or identical in mineralogy

(2) The products A, B and C are similar except that product Adoes have a slightly higher chlorite content

(3) The tails for B and C are similar, but tails A is clearly higher in talc. Hence, the ultrawet flotation agent clearly produced a higher loss of talc to the mill tails than did the butanol or butanol-citric acid reagents

The results from the amphibole separation are somewhat ambiguous because of the difficulties in obtaining reproduceable extractions from the products. However, the tourmaline added to products A and B was recovered to within ±10% for each, giving confidence in the efficiency of the separation. Based on optical estimates from these samples, and separations of the three done without tourmaline, it is concluded that all three products contain essentially similar concentrations of actinolite, and that its absolute concentration lies between 100 and 200 ppm.

CONCLUSIONS:

As a result of the mineralogical studies reported here, the following are concluded:

(1) Ores A, B and C are essentially identical with respect to their concentrations of magnesite, dolomite, chlorite and actinolite

(2) Tails B and C are identical with respect to talc, magnesite, dolomite and chlorite, but tails A is significantly richer in talc

(3) Products A, B and C are essentially identical with respect to their concentrations of magnesite, dolomite and actinolite; Product A contains a somewhat larger quantity of chlorite

(4) Amphibole separations from products are difficult to achieve quantitatively, but the addition of carbonate and silicate carriers seems promising in eliminating the difficulties

TABLE 1

X-RAY DIFFRACTION PEAK RATIOS FROM ORES, PRODUCTS AND TAILS

| | Magnesite/Talc | Dolomite/Talc | Chlorite/Talc |
|---|---|---|---|
| Ore A | 0.27 | 0.12 | 0.070 |
| Ore B | 0.23 | 0.11 | 0.086 |
| Ore C | 0.25 | 0.11 | 0.074 |
| Product A | Very low | Very low | 0.0100 |
| Product B | Very low | Very low | 0.0086 |
| Product C | Very low | Very low | 0.0085 |
| Tails A | 1.2 | 0.78 | 0.28 |
| Tails B | 10.9 | 5.7 | 2.6 |
| Tails C | 12.2 | 6.0 | 2.4 |

TABLE 2

ACID INSOLUBLE HEAVY LIQUID RESIDUES FROM PRODUCTS, ORES AND TAILS

| | PPM TOTAL | PPM ESTIMATED AMPHIBOLE |
|---|---|---|
| Ore A | 9000 | ∿3000 |
| Ore B | 10,500 | ∿3000 |
| Ore C | 8800 | ∿3000 |
| Product A | | 100-200* |
| Product B | | 100-200* |
| Product C | | 100-200* |
| Tails A | 34,600 | too much chlorite |
| Tails B | 36,100 | too much chlorite |
| Tails C | 44,100 | too much chlorite |

*See text

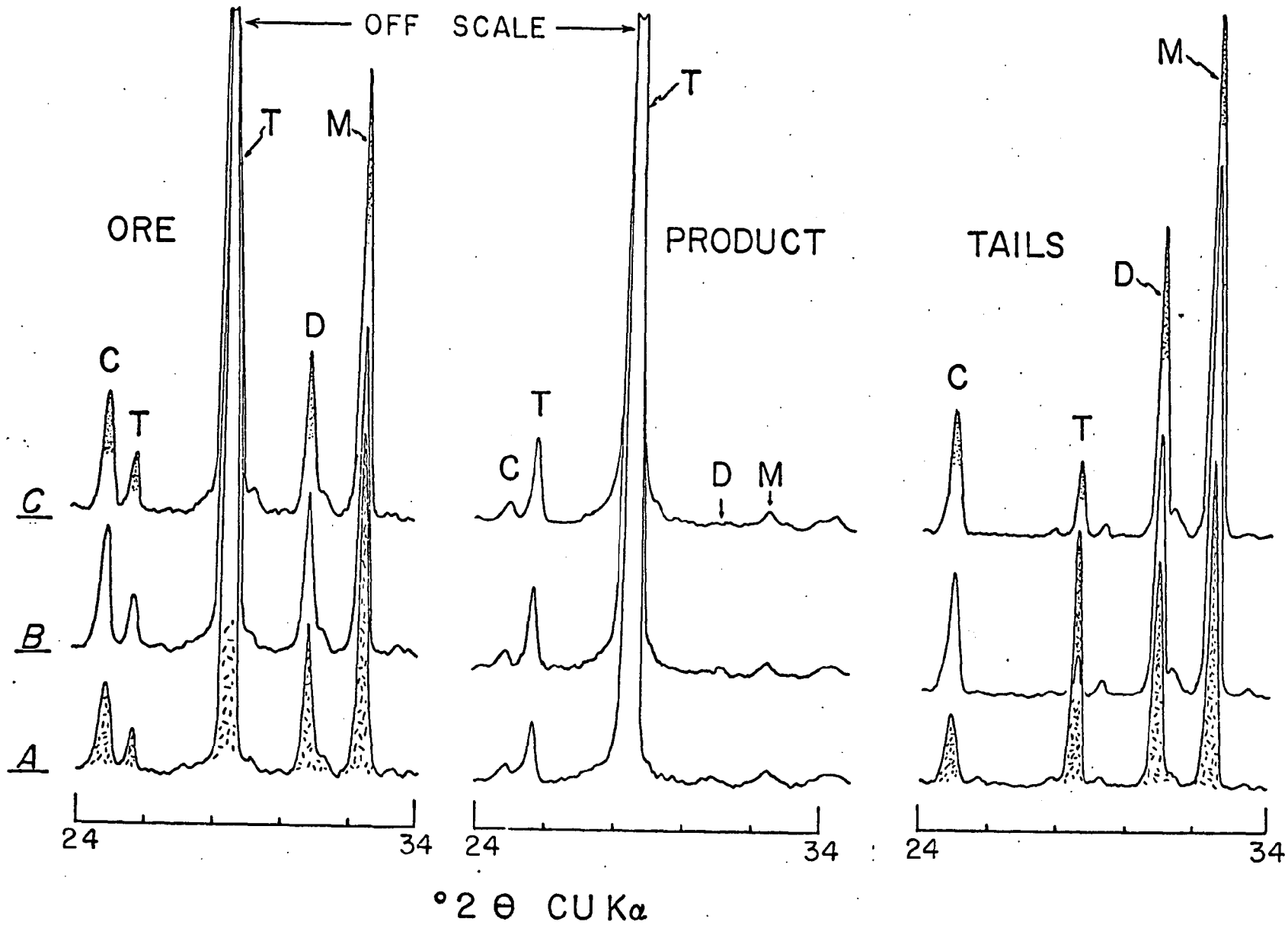



Figure 1 X-ray diffraction traces of ores, products and mill tails. Chlorite = C, talc = T, magnesite = M, and dolomite = D.